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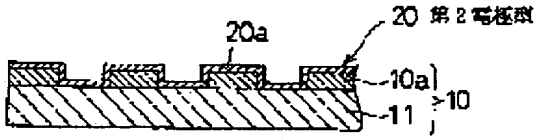
(71)Applicant : SUNCALL CORP
(72)Inventor : MITSUO SADAAKI

(54) MANUFACTURING METHOD OF ELECTRODE FOR FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To manufacture a quality electrode for fuel cell economically.
SOLUTION: A 1st electrode mold 10 (positive electrode mold) is manufactured by photo-forming, a 2nd electrode mold 20 (negative electrode mold) is manufactured by electric casting using the 1st electrode mold 10, a 3rd electrode mold (positive electrode mold) is manufactured by using the 2nd electrode mold 20, and the electrodes for fuel cells are economically manufactured by electric casting using the 3rd electrode mold.



LEGAL STATUS

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[Date of requesting appeal against examiner's decision of rejection]

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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In the approach of forming the electrode for fuel cells which comes to form the minute crevice of fine a large number in a metal thin sheet The 1st process which manufactures the conductive 1st electrode mold by photo forming, Next, the 2nd process which the mold front face of the 1st electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures the 2nd electrode mold of the shape of a sheet of the same structure as the electrode for fuel cells, Next, the 3rd process which manufactures the 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and has many minute crevices, Next, the manufacture approach of the electrode for fuel cells characterized by having the 4th process which the mold front face of the 3rd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures sheet-like the electrode for fuel cells.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About the manufacture approach of the electrode for fuel cells, especially this invention manufactures the 1st electrode mold by photo forming, carries out sequential manufacture of the 2nd electrode mold and the 3rd electrode mold by electroforming after that, and relates to the approach of manufacturing the electrode for fuel cells of high quality using this 3rd electrode mold.
[0002]
[Description of the Prior Art] Conventionally, photo forming which combined the pattern formation technique of a photoresist and the technique of electroforming is forming the electrode of electroplating in the electrode mold, making this electrode mold electrodeposit a metal layer by electroplating, and exfoliating this metal layer, and is a technique which manufactures the various metal sheet objects of the thickness of several 10 - 100 micrometers of numbers. This photo forming is put in practical use more widely than before, and according to this photo forming, since an ADDA cut does not occur like photo etching, it can perform foaming, such as still finer sharp various crevices and irregularity of a configuration, and a detailed hole. For example, a cutting edge, a detailed screen, a detailed mesh, a detailed filter, etc. are manufactured with the technique of photo forming outside the various masks for chemical vacuum deposition, and an electric shaver from the former.
[0003] On the other hand, an automaker is developing the component engineering wholeheartedly towards utilization of an automotive fuel cell recently. For example, a pottasium hydroxide solution is used for the electrolytic solution in the fuel cell which uses hydrogen and oxygen as a fuel, and it is O2 as positive active material to the front face of this positive electrode. Gas is supplied and it is H2 as a negative-electrode active material to the front face of a negative electrode. Gas is supplied, the current and the electrolytic solution which are generated between a positive electrode and a negative electrode are minded, and it is H2. Gas and O2 Gas is made to react and it generates electricity. as this kind of an electrode for fuel cells, the thin metal plate of nickel applies, for example -- having -- the front face of an electrode -- setting -- H2 O2 etc. -- the electrochemical reaction of an active material, the electrolytic solution, and a solid state electrode arises. Then, in order to promote contact to an electrode and an active material, many minute crevices with a diameter of about 1mm are formed in an electrode in all directions in a detailed pitch (about 1-2mm).

[0004]
[Problem(s) to be Solved by the Invention] When forming much crevices and irregularity in thin metal plates, such as said electrode for fuel cells, it usually forms by press forming. However, the manufacturing cost of metal mold becomes very expensive, and manufacturing the metal mold which forms many minute crevices with a diameter of about 1mm does not have it, although it is possible. [practical] Then, it is possible to manufacture the electrode for fuel cells by photo forming. However, an electrode mold is manufactured by photo forming, it is hard to release from mold smoothly [in case the angle of a minute crevice becomes Sharp too much it is easy to produce a minute weld flash-like projection, the comparatively big electrode for fuel cells is manufactured and an electrode is released from mold] only by forming the electrode for fuel cells by electroforming

using an electrode mold, and there is a problem of being easy to produce defects, such as a minute crack. The purpose of this invention is offering the manufacture approach of the electrode for fuel cells which can solve the aforementioned technical problem.
[0005]
[Means for Solving the Problem] In the approach of forming the electrode for fuel cells with which the manufacture approach of the electrode for fuel cells of claim 1 comes to form the minute crevice of fine a large number in a metal thin sheet The 1st process which manufactures the conductive 1st electrode mold by photo forming, Next, the 2nd process which the mold front face of the 1st electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures the 2nd electrode mold of the shape of a sheet of the same structure as the electrode for fuel cells, Next, the 3rd process which manufactures the 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and has many minute crevices, Next, it is characterized by having the 4th process which the mold front face of the 3rd electrode mold is made to electrodeposit a metal by electroforming, exfoliates after that, and manufactures sheet-like the electrode for fuel cells.
[0006] At the 1st process, the conductive 1st electrode mold is manufactured by photo forming. In this case, the base plate made from a nonmetal in which the electric conduction coat was formed on a metal base plate or a metal front face is used. To that base plate, by for example, the thing exposed where the masking negative which applied the photoresist of a positive type and formed the predetermined pattern in this photoresist is piled up Remove photoresists other than the photoresist of a predetermined pattern, and it has left the photoresist of the predetermined pattern. a base member is immersed in a predetermined electroplating bath (for example, sulfuric-acid nickel-plating bath), using the anode plate made from nickel, where a base plate is used as cathode, it electrocasts to a base plate, and a metal is electrodeposited -- making -- the -- if all photoresists are removed after carrying out a postexposure, the 1st electrode mold will be obtained.
[0007] Next, at the 2nd process, after applying a predetermined release agent (for example, red ocher) to the mold front face of the 1st electrode mold, it is immersed in said same electroplating bath, and using the anode plate made from nickel, where the 1st electrode mold is used as cathode The mold front face of the 1st electrode mold is made to electrodeposit a metal (for example, nickel) by electroforming, it exfoliates after that, and the 2nd electrode mold of the shape of a sheet of the same structure as the electrode for fuel cells is manufactured.
[0008] Next, where it formed the insulator layer in the mold front face of the 2nd electrode mold, and the field of the opposite side and said same predetermined release agent is applied to the mold front face of the 2nd electrode mold at the 3rd process The 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold is made to electrodeposit a metal (for example, nickel) by electroforming, exfoliates after that, and has many minute crevices in the condition that the 2nd electrode mold was immersed in said same electroplating bath is manufactured.
[0009] Next, where it formed the insulator layer in the mold front face of the 3rd electrode mold, and the field of the opposite side and said same predetermined release agent is applied to the mold front face of the 2nd electrode mold at the 4th process In the condition that the 3rd electrode mold was immersed in said same electroplating bath, the mold front face of the 3rd electrode mold is made to electrodeposit a metal (for example, nickel) by electroforming, it exfoliates after that, and sheet-like the electrode for fuel cells is manufactured.
[0010]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. First, the structure of the electrode for fuel cells of an automobile is explained. The electrode for fuel cells of an automobile (henceforth the electrode for cells) is applied to the positive electrode or negative electrode of a fuel cell, and, in the case of this operation gestalt, is a thing made from nickel.
[0011] As shown in drawing 1 - drawing 3 , the electrode 1 for cells is the thing of the shape of a sheet of the shape of a rectangle of for example, A4 seal size, thickness t is 200-300 micrometers, and many minute crevices 2 (outer diameter d =mm [about 1.0], a depth of h= 0.4-0.8mm) are formed in the direction in every direction in the shape of a matrix in the minute pitch a (for example,

a= 1.5-2.5mm). However, it may form so that the minute crevice 2 may not restrict being formed in the whole surface but may serve as a predetermined pattern.
[0012] Next, the manufacture approach of the aforementioned electrode for cells is explained.
The 1st process (manufacture of the electrode [1st] mold): As shown in drawing 4 , create the positive original edition 4 which made the part corresponding to the minute crevice 2 the black dot 3, and made other parts transparence using a transparence glass plate. The diameter of the black dot 3 in this positive original edition 4 is equal to the outer diameter d of the minute crevice 2 in drawing 3 , and the pitch of a black dot 3 in every direction is equal to the pitch a of the minute crevice 2.
[0013] Next, as shown in drawing 5 - drawing 8 , the conductive 1st electrode mold 10 is manufactured by photo forming. In this case, as shown in drawing 5 , while first forming the photoresist layer 12 which consists of a positive type photoresist of the suitable thickness for the top face of the metal (for example, the product made from phosphor bronze or the product made from stainless steel) base plate 11 of A4 seal size, where the positive original edition 4 is laid on top of the top face of that photoresist layer 12, from the upper part, ultraviolet rays and excimer laser are irradiated and are exposed. Since photoresist layers 12 other than the part corresponding to said black dot 3 are destroyed by this exposure, if the fluoric acid solution of suitable concentration etc. washes, the pattern which is equivalent to the positive original edition 4 as shown in drawing 6 can be developed.
[0014] Next, nickel plating as electroforming is performed until the base plate 11 with the same photoresist pattern as said positive original edition 4 is immersed in a nickel-plating organ bath and it becomes a photoresist layer 12 and the same thickness, as shown in drawing 7 . In this case, the liquid which uses for example, a nickel-sulfate solution as a principal component as plating liquid of a nickel-plating organ bath is applied, the base plate 11 is used as cathode, and plating processing (electroforming) is performed using the anode plate made from nickel. By this plating processing, the nickel of an anode plate will be electrodeposited to the pace plate 11 of cathode.
[0015] Then, if photoresist layer 12a corresponding to the matrix-like black dot 3 is destroyed and it washes by the penetrant remover suitable after that by picking out the base plate 11 from a nickel-plating organ bath, and irradiating ultraviolet rays and excimer laser after desiccation on the top face of the base plate 11, the 1st electrode mold 10 as shown in drawing 8 will be obtained. This 1st electrode mold 10 should also be called positive electrode mold.
[0016] The 2nd process (manufacture of the electrode [2nd] mold): At this 2nd process, it is the 2nd electrode mold 20 of the shape of a sheet which the mold front face of the aforementioned 1st electrode mold 10 is made to electrodeposit nickel, exfoliates after that, and has many minute crevices, and manufacture the electrode mold 1 for fuel cells, and the 2nd electrode mold 20 of the same structure.
[0017] In this case, the first suitable release agent for the mold front face of the 1st electrode mold 10 After applying (for example, red ocher) in the shape of a thin film, the 1st electrode mold 10 is immersed in the same nickel-plating organ bath as the above. Using the anode plate of the above, the same plating liquid, and the product made from nickel, only time amount sufficient as cathode carries out plating processing (electroforming) of the 1st electrode mold 10, and electrodeposted layer 20a of nickel with a thickness of about 200-300 micrometers is formed in the mold front face of the 1st electrode mold 10.
[0018] Then, if the 1st electrode mold 10 is picked out from a nickel-plating organ bath and electrodeposted layer 20a is exfoliated, the 2nd electrode mold 20 of the shape of a sheet with many minute crevices of the same structure as the electrode 1 for fuel cells will be obtained. In addition, this 2nd electrode mold 20 is equivalent to a negative electrode mold, and as shown in drawing 10 on the relation in which inferior-surface-of-tongue [this 2nd electrode type 20 of] side serves as a mold front face, it forms in the mold front face of the 2nd electrode mold 20, and the top face of the opposite side the insulator layer 21 which consists of a synthetic-resin ingredient.
[0019] The 3rd process (manufacture of the electrode [3rd] mold): Manufacture the 3rd electrode mold of the shape of a sheet which the mold front face of the 2nd electrode mold 20 is made to electrodeposit nickel, exfoliates after that, and has many minute crevices at this 3rd process. In this case, first, after applying said same release agent to the mold front face by the side of the inferior surface of tongue of the 2nd electrode mold 20 As the 2nd electrode mold 20 is immersed in the

same nickel-plating organ bath as the above, only time amount sufficient as cathode carries out plating processing (electrocasting processing) and the 2nd electrode mold 20 is shown in drawing 11 using the anode plate of the above, the same plating liquid, and the product made from nickel Electrodeposted layer 30a of nickel with a thickness of about 300-400 micrometers is formed in the mold front face of the 2nd electrode mold 20.

[0020] Then, if the 2nd electrode mold 20 is picked out from a nickel-plating organ bath and electrodeposted layer 30a is exfoliated, the 3rd electrode mold 30 of the shape of a sheet with many minute crevices as shown in drawing 12 R> 2 will be obtained. In addition, this 3rd electrode mold 30 should also be called positive electrode mold, and as shown in drawing 12 on the relation in which top-face [this 3rd electrode type 30 of] side serves as a mold front face, it forms in the mold front face of the 3rd electrode mold 30, and the inferior surface of tongue of the opposite side the insulator layer 31 which consists of a synthetic-resin ingredient.

[0021] The 4th process (manufacture of the electrode for fuel cells): At this 4th process, make the mold front face of the 3rd electrode mold 30 electrodeposit nickel, exfoliate after that, and manufacture the sheet-like electrode 1 for fuel cells. In this case, first, after applying said same release agent to the mold front face of the 3rd electrode mold 30 As the 3rd electrode mold 30 is immersed in the same nickel-plating organ bath as the above, only time amount sufficient as cathode carries out plating processing (electrocasting processing) and the 3rd electrode mold 30 is shown in drawing 13 using the anode plate of the above, the same plating liquid, and the product made from nickel Electrodeposted layer 1a of nickel with a thickness of about 200-300 micrometers is formed in the mold front face of the 3rd electrode mold 30.

[0022] Then, if the 3rd electrode mold 30 is picked out from a nickel-plating organ bath and electrodeposted layer 1a is exfoliated, the electrode 1 for fuel cells of the shape of a sheet with many minute crevices as shown in drawing 14 will be obtained.

[0023] According to the manufacture approach of the electrode for cells explained above, the conductive 1st electrode mold 10 is manufactured by photo forming. Next, make nickel electrodeposit by electroforming using this 1st electrode mold 10, and the 2nd electrode mold 20 is manufactured. Next, since make nickel electrodeposit by electroforming using this 2nd electrode mold 20, and manufacture the 3rd electrode mold 30, then use this 3rd electrode mold 30, nickel is made to electrodeposit by electroforming and the electrode for fuel cells is manufactured Even if it is the comparatively big electrode 1 for fuel cells, without the angle of a minute crevice not becoming Sharp too much, and a minute weld flash-like projection arising In case the electrode 1 for fuel cells is released from mold, become easy to release from mold smoothly, it is hard coming to also generate defects, such as a minute crack, and the electrode for fuel cells of high quality can be mass-produced economically.

[0024] Next, the modification which changes said operation gestalt partially is explained. The base plate 1 does not necessarily need to be metal and the thing in which the electric conduction film was formed on the front face of the base plate made from a nonmetal is sufficient as it. Moreover, although said operation gestalt explained as an example the case where the electrode 1 for fuel cells made from nickel was manufactured, the electrode 1 for fuel cells may not be restricted to the product made from nickel, and the product made from aluminum, the product made from chromium, and a copper electrode are sufficient as it. In this case, what is necessary is just to electrocast in the 4th process using which anode plates, such as aluminum, chromium, and copper, using respectively suitable plating liquid. In addition, it cannot be overemphasized that it can carry out with the gestalt which added various modification to said operation gestalt, without deviating from the meaning of this invention.

[0025]

[Effect of the Invention] According to the manufacture approach of the electrode for fuel cells of claim 1, the conductive 1st electrode mold (equivalent to a positive electrode mold) is manufactured by photo forming. Next, make a metal electrodeposit by electroforming using this 1st electrode mold, and the 2nd electrode mold (equivalent to a negative electrode mold) is manufactured. Next, since make a metal electrodeposit by electroforming using this 2nd electrode mold, and manufacture the 3rd electrode mold (equivalent to a positive electrode mold), then use this 3rd electrode mold, a metal is made to electrodeposit by electroforming and the electrode for fuel cells was manufactured

Even if it is a comparatively big electrode for fuel cells, without the angle of a minute crevice not becoming Sharp too much, and a minute weld flash-like projection arising In case an electrode is released from mold, become easy to release from mold smoothly, it is hard coming to also generate defects, such as a minute crack, and the electrode for fuel cells of high quality can be mass-produced economically.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the top view of the electrode for fuel cells concerning the operation gestalt of this invention.
[Drawing 2] It is the important section enlarged drawing of the electrode for fuel cells.
[Drawing 3] It is the important section expanded sectional view of the electrode for fuel cells.
[Drawing 4] It is the important section expansion top view of the positive original edition.
[Drawing 5] It is the important section expanded sectional view of a base plate, a photoresist layer, and the positive original edition.
[Drawing 6] It is the important section expanded sectional view of a base plate and a photoresist layer.
[Drawing 7] It is the important section expanded sectional view of a base plate, a photoresist layer, and an electrodeposted layer.
[Drawing 8] It is the important section expanded sectional view of the 1st electrode mold.
[Drawing 9] It is the important section expanded sectional view of the 1st electrode mold and an electrodeposted layer.
[Drawing 10] It is the important section expanded sectional view of the 2nd electrode mold.
[Drawing 11] It is the important section expanded sectional view of the 2nd electrode mold and an electrodeposted layer.
[Drawing 12] It is the important section expanded sectional view of the 3rd electrode mold.
[Drawing 13] It is the important section expanded sectional view of the 3rd electrode mold and an electrodeposted layer.
[Drawing 14] It is the important section expanded sectional view of the electrode for fuel cells which exfoliated from the 3rd electrode mold.
[Description of Notations]
1 Electrode for Fuel Cells
2 Minute Crevice
10 1st Electrode Mold
20 2nd Electrode Mold
30 3rd Electrode Mold

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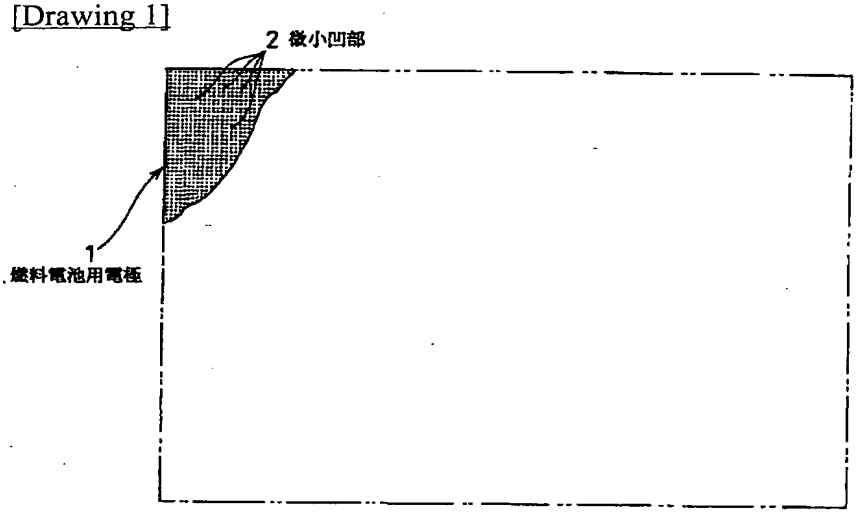
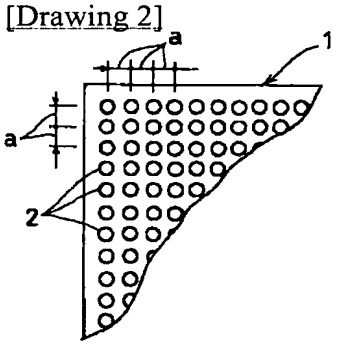
* NOTICES *

DRAWINGS

[Drawing 1]



[Drawing 2]



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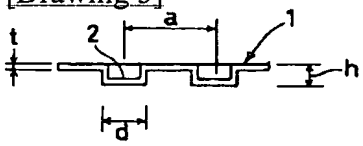
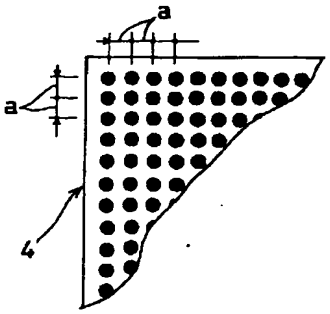
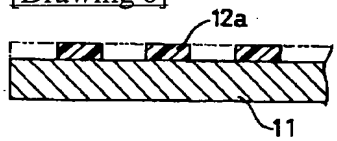


[Drawing 4]



[Drawing 5]

[Drawing 6]



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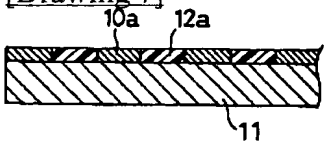
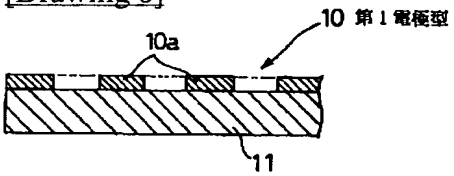
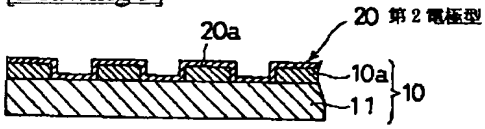


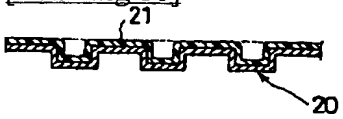
[Drawing 8]



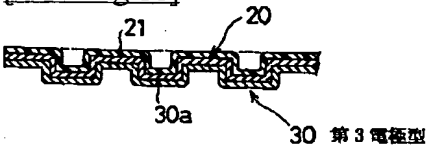
[Drawing 9]



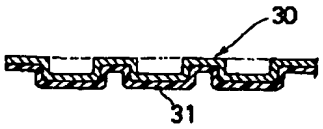
[Drawing 10]



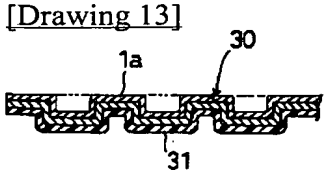
[Drawing 11]



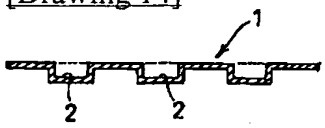
[Drawing 12]



[Drawing 13]



[Drawing 14]



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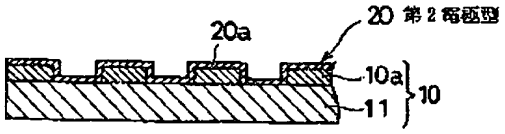
(71)出願人　000175722
サンコール株式会社
京都府京都市右京区梅津西浦町14番地
(72)発明者　湯昭　貞昭
京都市右京区梅津西浦町14番地　サンコール株式会社内
(74)代理人　100099004
弁理士　岡村　俊雄

Fターム(参考)　5H018 AA03 BB07 EE02
5H026 AA03 BB00 BB04 CC04 EE02

(54)【発明の名称】　燃料電池用電極の製造方法

(57)【要約】
【課題】　燃料電池用電極をプレス成形で製作する場合は、金型が非常に高価になり現実的でなく、燃料電池用電極をフォトフォーミングの技術だけで製作すると、高品質のものを製作することが難しい。
【解決手段】フォトフォーミングにより第1電極型10（ポジ電極型）を製作し、この第1電極型10を用いて電気鋳造することで第2電極型20（ネガ電極型）を製作し、この第2電極型20用いて電気鋳造することで第3電極型（ポジ電極型）を製作し、その第3電極型を用いて電気鋳造することで高品質の燃料電池用電極を経済的に製作する。



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【特許請求の範囲】

【請求項１】　金属製の薄いシートに細かい多数の微小凹部を形成してなる燃料電池用電極を形成する方法において．

フォトフォーミングにより導電性の第１電極型を製作する第１の工程と．

次に第１電極型の型表面に金属を電気鋳造で電着させその後剥離して燃料電池用電極と同様の構造のシート状の第２電極型を製作する第２の工程と．

次に第２電極型の型表面に金属を電気鋳造で電着させその後剥離して多数の微小凹部のあるシート状の第３電極型を製作する第３の工程と．

次に第３電極型の型表面に金属を電気鋳造で電着させその後剥離してシート状の燃料電池用電極を製作する第４の工程と、

を備えたことを特徴とする燃料電池用電極の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】　本発明は燃料電池用電極の製造方法に関し．特にフォトフォーミングにより第１電極型を製作し．その後電気鋳造により第２電極型．第３電極型を順次製作し、この第３電極型を用いて高品質の燃料電池用電極を製造する方法に関する。

【０００２】

【従来の技術】　従来、フォトレジストのパターン形成技術と電気鋳造の技術とを組み合わせたフォトフォーミングは、電気メッキの電極を電極型に形成しておき、この電極型に電気メッキにより金属層を電着させ．この金属層を剥離することで、数１０～数１００μmの厚さの種々の金属製シート体を製作する技術である。このフォトフォーミングは従来より広く実用化されており．このフォトフォーミングによれば、フォトエッチングのようにアンダーカットが発生しないため．一層細かいシャープな種々の形状の凹部や凹凸や微細な穴などのフォーミングを行うことができる。例えば、従来から、種々の化学蒸着用マスク．電気カミソリの外刃．微細スクリーン．微細メッシュ、微細フィルタなどは、フォトフォーミングの技術で製作されている。

【０００３】一方、最近自動車メーカーは自動車用燃料電池の実用化に向けてその要素技術を鋭意開発中である。例えば、水素と酸素を燃料とする燃料電池では、電解液に水酸化カリウム溶液を用い、この正極の表面に正極活物質としてのO₂ガスを供給し．負極の表面に負極活物質としてのH₂ガスを供給し、正極と負極間に発生する電流と電解液を介して．H₂ガスとO₂ガスを反応させて発電する。この種の燃料電池用電極としては、例えばニッケルの薄金属板が適用され．電極の表面においてH₂やO₂などの活物質と電解液と固体電極との電気化学反応が生じる。そこで．電極と活物質との接触を促進する為に、電極には直径約１ｍｍ程度の微小凹部が微細ピッチ（約１～２ｍｍ）で縦横に多数形成される。

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【０００４】

【発明が解決しようとする課題】　前記燃料電池用電極など薄い金属板に多数の凹部や凹凸を形成する場合は、通常プレス成形により形成する。しかし、直径約１ｍｍ程度の微小の凹部を多数形成する金型を製作することは可能ではあるが．金型の製作費が非常に高価になり、実用的でない。そこで、フォトフォーミングにより燃料電池用電極を製作することが考えられる。しかし．フォトフォーミングにより電極型を製作し．電極型を用いて電気鋳造により燃料電池用電極を形成するだけでは．微小凹部の角がシャープになり過ぎ、バリ状の微小突起が生じやすく、比較的大きな燃料電池用電極を製作する際には電極を離型する際に円滑に離型しにくく、微小なクラックなどの欠陥が生じやすい、という問題がある。本発明の目的は、前記の課題を解決できるような燃料電池用電極の製造方法を提供することである。

【０００５】

【課題を解決するための手段】　請求項１の燃料電池用電極の製造方法は、金属製の薄いシートに細かい多数の微小凹部を形成してなる燃料電池用電極を形成する方法において、フォトフォーミングにより導電性の第１電極型を製作する第１の工程と．次に第１電極型の型表面に金属を電気鋳造で電着させその後剥離して燃料電池用電極と同様の構造のシート状の第２電極型を製作する第２の工程と、次に第２電極型の型表面に金属を電気鋳造で電着させその後剥離して多数の微小凹部のあるシート状の第３電極型を製作する第３の工程と．次に第３電極型の型表面に金属を電気鋳造で電着させその後剥離してシート状の燃料電池用電極を製作する第４の工程とを備えたことを特徴とするものである。

【０００６】第１工程では．フォトフォーミングにより導電性の第１電極型を製作する。この場合、金属製のベース板又は表面に導電被膜を形成した非金属製のベース板を用い、そのベース板に例えばポジ型のフォトレジストを塗布し、このフォトレジストに所定のパターンを形成したマスキング原板を重ねた状態で露光することで、所定のパターンのフォトレジスト以外のフォトレジストを除去し、その所定のパターンのフォトレジストを残したまま、ベース部材を所定の電気メッキ浴（例えば、硫酸ニッケルメッキ浴）に浸漬し、ニッケル製の陽極を用い．ベース板を陰極とした状態でベース板に電気鋳造を施して金属を電着させ、その後露光してから全てのフォトレジストを除去すると．第１電極型が得られる。

【０００７】次に、第２の工程では．第１電極型の型表面に所定の離型剤（例えば．ベンガラ）を塗布してからそれを前記同様の電気メッキ浴に浸漬し、ニッケル製の陽極を用い、第１電極型を陰極とした状態で、第１電極型の型表面に金属（例えば．ニッケル）を電気鋳造で電着させその後剥離して燃料電池用電極と同様の構造のシ

ート状の第２電極型を製作する。

【０００８】次に、第３の工程では、第２電極型の型表面と反対側の面には絶縁膜を形成し、第２電極型の型表面には前記同様の所定の離型剤を塗布した状態で、第２電極型を前記同様の電気メッキ浴に浸漬した状態で、第２電極型の型表面に金属（例えば、ニッケル）を電気鋳造で電着させその後剥離して多数の微小凹部のあるシート状の第３電極型を製作する。

【０００９】次に、第４の工程では、第３電極型の型表面と反対側の面には絶縁膜を形成し、第２電極型の型表面には前記同様の所定の離型剤を塗布した状態で、第３電極型を前記同様の電気メッキ浴に浸漬した状態で、第３電極型の型表面に金属（例えば、ニッケル）を電気鋳造で電着させその後剥離してシート状の燃料電池用電極を製作する。

【００１０】

【発明の実施の形態】　以下、本発明の実施の形態について図面を参照して説明する。最初に、自動車の燃料電池用電極の構造について説明する。自動車の燃料電池用電極（以下、電池用電極という）は、燃料電池の正極又は負極に適用されるもので、本実施形態の場合ニッケル製のものである。

【００１１】図１～図３に示すように、電池用電極１は、例えばＡ４判サイズの矩形状のシート状のもので、厚さｔは例えば２００～３００μｍであり、多数の微小凹部２（外径ｄ＝約１．０ｍｍ、深さｈ＝０．４～０．８ｍｍ）が縦横方向に微小ピッチａ（例えば、ａ＝１．５～２．５ｍｍ）でマトリックス状に形成されている。但し、微小凹部２が全面に形成されるとは限らず、所定のパターンとなるように形成する場合もある。

【００１２】次に、前記の電池用電極の製造方法について説明する。

第１工程（第１電極型の製作）：図４に示すように、微小凹部２に対応する部分を黒丸３にし、その他の部分を透明にしたポジ原版４を透明ガラス板を用いて作成する。このポジ原版４における黒丸３の直径は、図３における微小凹部２の外径ｄに等しく、黒丸３の縦横のピッチは微小凹部２のピッチａに等しい。

【００１３】次に、図５～図８に示すように、フォトファブリケーションにより導電性の第１電極型１０を製作する。この場合、まず、図５に示すように、Ａ４判サイズの金属製（例えばリン青銅製又はステンレス製）のベース板１１の上面に適当な厚さのポジ型フォトレジストからなるフォトレジスト層１２を形成するとともに、そのフォトレジスト層１２の上面にポジ原版４を重ね合わせた状態で、上方から紫外線やエキシマレーザを照射して露光する。この露光により、前記黒丸３に対応する部分以外のフォトレジスト層１２が破壊されるので、適当な濃度のアルカリ溶液等で洗浄すると、図６に示すようにポジ原版４に相当するパターンを現像することができる。

【００１４】次に、図７に示すように、前記ポジ原版４と同様のフォトレジストパターンのあるベース板１１をニッケルメッキ浴槽に浸漬し、フォトレジスト層１２と同厚になるまで電気鋳造としてのニッケルメッキを施す。この場合、ニッケルメッキ浴槽のメッキ液としては例えば硫酸ニッケル溶液を主成分とする液を適用し、ベース板１１を陰極とし、ニッケル製の陽極を用いてメッキ処理（電気鋳造）を行う。このメッキ処理により、陽極のニッケルが陰極のベース板１１に電着することになる。

【００１５】その後、ベース板１１をニッケルメッキ浴槽から取り出して乾燥後、ベース板１１の上面に紫外線やエキシマレーザを照射することにより、マトリックス状の黒丸３に対応するフォトレジスト層１２ａを破壊し、その後適当な洗浄液で洗浄すると、図８に示すような第１電極型１０が得られる。この第１電極型１０はポジ電極型とも言うべきものである。

【００１６】第２工程（第２電極型の製作）：この第２工程では、前記の第１電極型１０の型表面にニッケルを電着させその後剥離して多数の微小凹部のあるシート状の第２電極型２０であって、燃料電池用電極型１と同様の構造の第２電極型２０を製作する。

【００１７】この場合、まず、第１電極型１０の型表面に適当な離型剤（例えば、ベンガラ）を薄膜状に塗布してから、第１電極型１０を前記と同様のニッケルメッキ浴槽に浸漬し、前記と同様のメッキ液とニッケル製の陽極を用い、第１電極型１０を陰極として十分な時間だけメッキ処理（電気鋳造）して第１電極型１０の型表面に約２００～３００μｍの厚さのニッケルの電着層２０ａを形成する。

【００１８】その後、第１電極型１０をニッケルメッキ浴槽から取り出して、電着層２０ａを剥離すると燃料電池用電極１と同様の構造の多数の微小凹部のあるシート状の第２電極型２０が得られる。尚、この第２電極型２０は、ネガ電極型に相当するものであり、この第２電極型２０の下面側が型表面となる関係上、図１０に示すように、第２電極型２０の型表面と反対側の上面には合成樹脂材料からなる絶縁膜２１を形成しておく。

【００１９】第３工程（第３電極型の製作）：この第３工程では、第２電極型２０の型表面にニッケルを電着させその後剥離して多数の微小凹部のあるシート状の第３電極型を製作する。この場合、まず、第２電極型２０の下面側の型表面に前記同様の離型剤を塗布してから、第２電極型２０を前記と同様のニッケルメッキ浴槽に浸漬し、前記と同様のメッキ液とニッケル製の陽極を用い、第２電極型２０を陰極として十分な時間だけメッキ処理（電鋳処理）して、図１１に示すように、第２電極型２０の型表面に約３００～４００μｍの厚さのニッケルの電着層３０ａを形成する。

【００２０】その後、第２電極型２０をニッケルメッキ

浴槽から取り出して、電着層３０ａを剥離すると、図１２に示すような多数の微小凹部のあるシート状の第３電極型３０が得られる。尚、この第３電極型３０は、ポジ電極型とも言うべきものであり、この第３電極型３０の上面側が型表面となる関係上、図１２に示すように、第３電極型３０の型表面と反対側の下面には合成樹脂材料からなる絶縁膜３１を形成しておく。

【００２１】第４工程（燃料電池用電極の製作）：この第４工程では、第３電極型３０の型表面にニッケルを電着させその後剥離してシート状の燃料電池用電極１を製作する。この場合、まず、第３電極型３０の型表面に前記同様の離型剤を塗布してから、第３電極型３０を前記と同様のニッケルメッキ浴槽に浸漬し、前記と同様のメッキ液とニッケル製の陽極を用い、第３電極型３０を陰極として十分な時間だけメッキ処理（電鋳処理）して、図１３に示すように、第３電極型３０の型表面に約２００～３００μｍの厚さのニッケルの電着層１ａを形成する。

【００２２】その後、第３電極型３０をニッケルメッキ浴槽から取り出して、電着層１ａを剥離すると、図１４に示すような多数の微小凹部のあるシート状の燃料電池用電極１が得られる。

【００２３】以上説明した電池用電極の製造方法によれば、フォトフォーミングにより導電性の第１電極型１０を製作し、次にこの第１電極型１０を用いて電気鋳造によりニッケルを電着させて第２電極型２０を製作し、次にこの第２電極型２０を用いて電気鋳造によりニッケルを電着させて第３電極型３０を製作し、次にこの第３電極型３０を用いて電気鋳造によりニッケルを電着させて燃料電池用電極を製作するので、微小凹部の角がシャープになり過ぎることがなく、バリ状の微小突起が生じることもなく、比較的大きな燃料電池用電極１であっても、その燃料電池用電極１を離型する際に円滑に離型しやすくなり、微小なクラックなどの欠陥も生じにくくなり、高品質の燃料電池用電極を経済的に量産できるようになる。

【００２４】次に、前記実施形態を部分的に変更する変形例について説明する。ベース板１は必ずしも金属製でなくともよく、非金属製のベース板の表面に導電膜を形成したものでもよい。また、前記実施形態では、ニッケル製の燃料電池用電極１を製造する場合を例として説明したが、燃料電池用電極１はニッケル製に限るものではなく、アルミニウム製やクロム製や銅製の電極でもよい。この場合、第４工程において、夫々適切なメッキ液を用い、アルミニウム、クロム、銅などの何れかの陽極を用いて電気鋳造を行えばよい。その他、本発明の趣旨を逸脱することなく、前記実施形態に種々の変更を付加した形態で実施可能であることは言うまでもない。

【００２５】

【発明の効果】　請求項１の燃料電池用電極の製造方法によれば、フォトフォーミングにより導電性の第１電極型（ポジ電極型に相当）を製作し、次にこの第１電極型を用いて電気鋳造により金属を電着させて第２電極型（ネガ電極型に相当）を製作し、次にこの第２電極型を用いて電気鋳造により金属を電着させて第３電極型（ポジ電極型に相当）を製作し、次にこの第３電極型を用いて電気鋳造により金属を電着させて燃料電池用電極を製作するようにしたので、微小凹部の角がシャープになり過ぎることがなく、バリ状の微小突起が生じることもなく、比較的大きな燃料電池用電極であっても、電極を離型する際に円滑に離型しやすくなり、微小なクラックなどの欠陥も生じにくくなり、高品質の燃料電池用電極を経済的に量産できるようになる。

【図面の簡単な説明】

【図１】本発明の実施形態に係る燃料電池用電極の平面図である。

【図２】燃料電池用電極の要部拡大図である。

【図３】燃料電池用電極の要部拡大断面図である。

【図４】ポジ原版の要部拡大平面図である。

【図５】ベース板とフォトレジスト層とポジ原版の要部拡大断面図である。

【図６】ベース板とフォトレジスト層の要部拡大断面図である。

【図７】ベース板とフォトレジスト層と電着層の要部拡大断面図である。

【図８】第１電極型の要部拡大断面図である。

【図９】第１電極型と電着層の要部拡大断面図である。

【図１０】第２電極型の要部拡大断面図である。

【図１１】第２電極型と電着層の要部拡大断面図である。

【図１２】第３電極型の要部拡大断面図である。

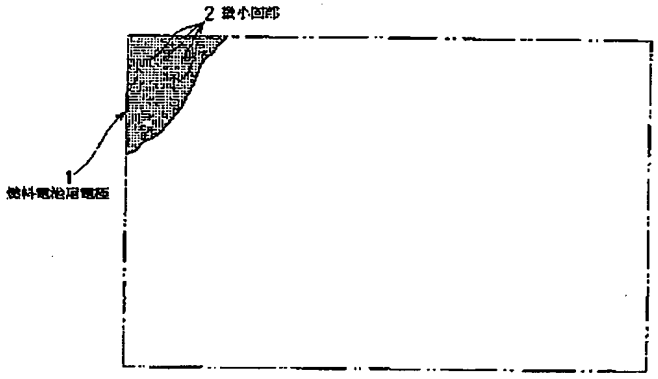
【図１３】第３電極型と電着層の要部拡大断面図である。

【図１４】第３電極型から剥離した燃料電池用電極の要部拡大断面図である。

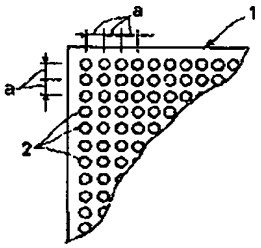
【符号の説明】

１	燃料電池用電極
２	微小凹部
１０	第１電極型
２０	第２電極型
３０	第３電極型

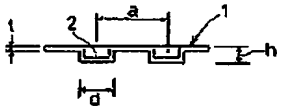
【図1】



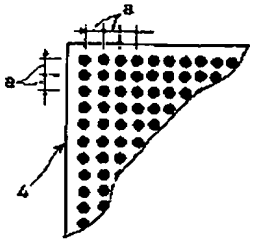
【図2】



【図3】

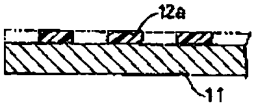


【図4】



【図5】

【図6】



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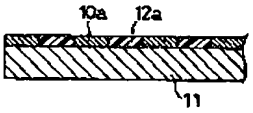
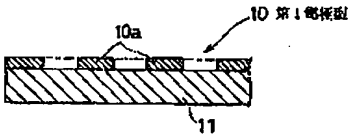
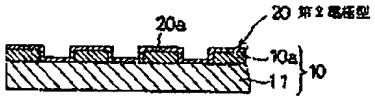


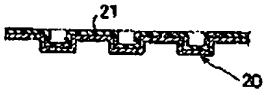
【図8】



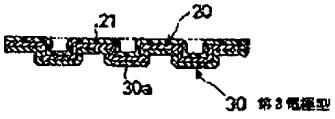
【図9】



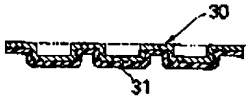
【図10】



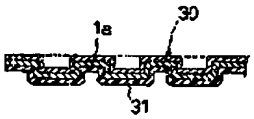
【図11】



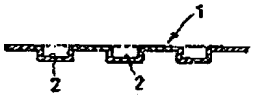
【図12】



【図13】



【図14】



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DOCUMENTS CONSIDERED PERTINENT			
Category	Documents cited stating pertinent parts where necessary	Claims concerned of the examined application	
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X	WO 01/80286 A (PENN STATE RES FOUND) 25 OCTOBER 2001 (2001-10-25)	1-5, 8, 10-12, 15	
	PAGE 1, LINE 23- PAGE 2, LINE 14 *PAGE 2, LINE 7-29* *PAGE 14, LINE 6 - PAGE 18, LINE 3* *PAGE 42, LINE 9 - PAGE 49, LINE 19; FIGURES 5-10*	1-7,10	Search Classes (Int. Cl. 7) H01M
A	*PAGE 23, LINE 26 - PAGE 25, LINE 3*	9	
X	EP 1 160 900 A (RIKEN KK) 5 DECEMBER 2001 (2001-12-05)	1	
Y	*PAGE 4, LINE 13 - PAGE 5, LINE 54; FIGURES 2-6*	2-6	
A	*PAGE 7, LINE 11-PAGE 8, LINE 51*	13,14	
X	US 2002/193241 A1 (MORSE JEFFREY D ET AL) 19 DECEMBER 2002 (2002-12-19)	1-5, 7, 10,11 13,15	
Y	*LINES 18-29*	2-6	
Y	*LINE 20*	11	
Y	DE 198 35 759 A (OPEL ADAM AG) 17 FEBRUARY 2000 (2000-02-17) *COLUMN 2, LINE 3 - COLUMN 3, LINE 17; FIGURE 2*	11	

Date of Search: 6 July 2004

Examiner: Thanos, I

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- &: members of the same family, corresponding document

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Category	Documents cited stating pertinent parts where necessary	Claims concerned of the examined application	
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A	*COLUMN 2, LINE 53 - COLUMN 6, LINE 58*	10	
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Date of Search: 6 JULY 2004

Examiner: Thanos, I

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